ARI Research Note 85-103

AD-A167 740

HUMAN FACTORS RESEARCH IN AIRCREW PERFORMANCE AND TRAINING: ANNUAL SUMMARY REPORT 1 September 81 - 31 August 82

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for

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Research Institute for the Behavioral and Social Sciences

December 1985

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U. S. ARMY RESEARCH INSTITUTE

FOR THE BEHAVIORAL AND SOCIAL SCIENCES

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QUALITY INSPECTED 3

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARI Research Note 85-103	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) HUMAN FACTORS RESEARCH IN AIRCREW PERFORMANCE AND TRAINING: ANNUAL SUMMARY REPORT 1 September 81 - 31 August 82		5. TYPE OF REPORT & PERIOD COVERED Interim Report Sept. 81 - Aug. 82
		6. PERFORMING ORG. REPORT NUMBER ASI-479-19
7. AUTHOR(s) Kenneth D. Cross (Editor)		8. CONTRACT OR GRANT NUMBER(s) MDA 903-81-C-0504
9. PERFORMING ORGANIZATION NAME AND ADDRESS Anacapa Sciences, Inc. P.O. Box 485 Fort Rucker, AL 36362		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q263743A792, 2Q263743A793, 2Q263743A794
11. CONTROLLING OFFICE NAME AND ADDRESS Army Research Institute Field Unit at Fort Rucker, Attn: PERI-IR Fort Rucker, AL 36362		12. REPORT DATE December 1985
		13. NUMBER OF PAGES 76
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) U.S. Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue, Alexandria, VA 22333-5600		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE n/a

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

- -

18. SUPPLEMENTARY NOTES

Charles A. Gainer, contracting officer's representative

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

AHIP Scout,	Synthetic Flight Training System,
Scout Team Combat Mission Simulator,	Cost and Training Effectiveness,
Training Device Requirements,	Warrent Officer Retention,
Aircrew Training Manual Validation,	Flight Aptitude Selection Test,
Iteration Requirements,	AWO Attrition, (over)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents a summary of the work performed under contract number MDA 903-81-C-0504, "Human Factors Research in Aircrew Performance and Training", for the Army Research Institute Field Unit at Fort Rucker, Alabama. The report contains summary descriptions for each of the eleven projects on which contractor personnel worked during the first contract year - 1 September 1981 to 31 August 1982. Each summary description contains (a) a background section that describes

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ARI Research Note 85-103

(Program of Instruction),

19 Key Words (continued)

Revised Flight Aptitude Selection Test,
Selection Test Development,
Gradeslip Design,
Inflight Performance Evaluation,
Individual Ready Reserve POI)
AH-64 Aircrew Selection,
Qualification Training in Simulators.

20 Abstract (continued)

the rationale for the research need and the project objectives, b) a research approach that describes the tasks and activities required to fulfill the project objectives, and c) a project status section that describes the work completed, preliminary findings (if available), and the anticipated project completion date.

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INTRODUCTION

Anacapa Sciences, Inc. (ASI) is under contract to provide on-site research support to the Army Research Institute (ARI) Field Unit at Fort Rucker, Alabama. This contract (Contract No. MDA903-81-C-0504) commenced on 1 September 1981 and is scheduled to terminate on 31 August 1985. One of the contract requirements is to prepare a Yearly Summary Report that presents a brief description of each project that ASI personnel worked on during the contract year. This report was prepared to fulfill that requirement; it describes the projects on which ASI personnel worked during the first contract year--1 September 1981 through 31 August 1982.

This report contains summary descriptions for each of the eleven projects that were assigned to ASI during the first contract year. All project summaries follow the same format. Each summary begins with a background section presenting the information that an uninitiated reader needs to understand the requirement for the project. Also, if relevant, the background section describes the key events that led to the project's initiation. The background section is followed by a concise statement of the need for the research and the project objectives.

The next section of the project summary, entitled "Research Approach," contains a moderately detailed description of what must be (or has been) done to accomplish the project objectives. For some projects, the research approach is an experiment in the strict sense of the word. For other projects, the research approach is a set of analytical or product-development tasks. In the research approach section, tasks and activities completed before the end of the first contract year are described in the past tense; tasks and activities planned but not completed are described in the future tense.

The final section of the project summaries describes the status of the project and, if available, preliminary findings. An attempt was made to provide the reader with an indication of when the project work

will be completed and when the project results will be documented in a preliminary or a final report. Readers who need information that is more current or more detailed than is presented in this report are invited to contact Mr. Charles A. Gainer, Chief, ARI Field Unit. His address and phone number are shown below.

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It is important to point out that the projects summarized in this report represent only a portion of the projects presently under way at the ARI Fort Rucker Field Unit; ARI's research program also includes numerous projects that are the sole responsibility of ARI personnel.

The names and titles of members of ASI's Fort Rucker research team are listed below. Also listed are the ARI personnel who served as the point of contact (POC) for one or more of the projects summarized herein. Every POC worked closely with ASI personnel and provided both technical direction and administrative support during all phases of the effort.

- Dr. Kenneth D. Cross, Program Manager
- Mr. Theodore B. Aldrich, Project Director
- Dr. Jack B. Keenan, Project Director
- Dr. Robert E. Lockwood, Project Director
- Dr. Sandra S. Martin, Project Director
- Dr. Kathleen A. O'Donnell, Project Director
- Dr. John W. Ruffner, Project Director
- Mr. Daniel T. Wick, Project Director
- Mr. Steven L. Millard, Instructor Pilot
- Mr. Walker Craddock, Operations Research Analyst
- Mr. David G. Russell, Data Analyst
- Mr. Ronald J. Cohen, Research Associate
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- Mrs. M. Ernestine Pridgen, Technical Assistant
- Miss Susie Britt, Data Processor

- Dr. William R. Bickley, ARI POC
- Dr. Jack H. McCracken, ARI POC
- Dr. Michael G. Sanders, ARI POC
- Dr. Brian D. Shipley, Jr., ARI POC
- Dr. Robert H. Wright, ARI POC

DEVELOPMENT OF A SEPARATION FORM FOR ARMY AVIATION WARRANT OFFICERS

Dr. Sandra S. Martin, Project Director

BACKGROUND

In October 1979, Warrant Officer Division, U. S. Army Military Personnel Center (MILPERCEN), requested that the Army Research Institute (ARI) provide research support to investigate an apparent trend toward decreased retention of aviation warrant officers (AWOs). The request stemmed from retention data obtained by MILPERCEN that indicated a significant decrease in retention of first-term AWOs. These AWOs leave the Army at the end of the three-year obligation incurred by attending the Army's Initial Entry Rotary Wing (IERW) flight training program. This career point is the first opportunity for AWOs to separate from the Army following completion of flight training.[1]

Specifically, the retention data indicated that, for those AWOs who completed training during the period FY 1973 through FY 1975, retention beyond initial obligation remained relatively stable at approximately 65 percent. For AWOs who completed flight training during FY 1976 and FY 1977T[2], however, retention rate at the same career point had declined to approximately 45 percent (Bills, 1979).

MILPERCEN was concerned that the increased rate of AWO attrition might signal the onset of an aviator retention problem that already was troubling the other military services. MILPERCEN also was concerned that a continued high rate of AWO separation might seriously reduce the Army's aviation readiness and combat effectiveness. The problem was exacerbated by the following additional considerations (Everhart & Sanders, 1981):

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[1]The initial obligation was changed from three to four years effective 1 October 1978.

[2]Beginning with FY 1977, the fiscal year was changed from 1 July through 30 June to 1 October through 30 September. FY 1977T represents the period 1 July 1976 through 30 September 1976 during which the transition to the new fiscal year concept occurred.

- increasing costs of aviator training and replacement,
- increasing aviation force structure needs,
- limitations in aviator training rates, and
- decreasing manpower pool for recruitment of aviators.

In response to MILPERCEN's request for research assistance, ARI conducted a worldwide survey of Army aviators. The survey used a questionnaire, constructed by ARI, to identify factors that contribute to attrition of AWOs. The questionnaire items were organized into two sections: a personal data section and a career factors section. Items in the personal data section were designed to provide information about the demographic characteristics, assignments, and career intentions of the respondents. Items in the career factors section were designed to determine the amount of influence that each of 46 factors have on AWOs' decisions to leave the Army.

During the four-month period from September to December 1980, approximately 900 AWOs and 300 commissioned officer aviators were surveyed. The AWOs were subsequently defined as retainees or attritees. The distinction was based on the AWOs' stated intentions to remain in or to leave the Army, respectively. Data provided by the survey identified demographic characteristics, such as age, rank, and MOS, that are related to AWO attrition (Sundy, Ruffner, & Wick, 1981). In addition, the survey provided three different sources of information about the career factors that influence AWOs' decisions to leave the Army--AWO attritees (self-reports), AWO retainees (peer perceptions), and commissioned officer aviators (supervisor perceptions) (Rogers and King, 1981).

The ten most influential factors identified by the AWO attritees represent three major areas of concern: (a) pay and benefits, (b) leadership and supervision, and (c) career and assignment factors (Rogers & King, 1981). These areas subsequently became the focus of a series of initiatives that were developed by MILPERCEN to enhance retention of AWOs. Included in the initiatives was an overall increase in flight pay, as well as equalization of flight pay between warrant officer and commissioned officer aviators (Morgan & Johnson, 1981).

NEED/PROBLEM

ARI's survey provides a comprehensive view of AWO retention at a particular time. A more complete understanding of AWO retention requires development and implementation of a mechanism that provides continuous feedback about AWO retention. In recognition of the need for continuous assessment of AWO retention, MILPERCEN has tasked ARI to develop a separation questionnaire to be administered to all AWOs who leave the Army.

Information provided by the questionnaire will be used to implement and maintain a continuous, closed-loop feedback system that will provide MILPERCEN with current information about (a) the number and types of AWOs who separate from the Army, and (b) the type and importance of factors that influence AWOs' decisions to leave the Army. This information, in turn, can be used by the Department of the Army (DA) as an aid in activities such as:

- determining the number of aviators, by MOS, that must be trained for replacement,
- *planning and projecting the AWO personnel strength, and*
- developing and assessing Army policies that impact on retention of AWOs.

Major users of the information include MILPERCEN, the Deputy Chief of Staff for Personnel (DCSPER), and the U. S. Army Aviation Center (USAAVNC).

PROJECT OBJECTIVES

The project has four specific research objectives. The objectives are as follows:

- to identify the factors that historically have been related to military aviator retention,
- to develop a preliminary version of the separation questionnaire,
- to conduct pretests of the preliminary questionnaire and use the resulting information to develop the final version of the separation questionnaire, and
- to develop and implement a data analysis plan for analyzing data yielded by the separation questionnaire.

RESEARCH APPROACH

The initial step in developing the questionnaire is an extensive review of contemporary retention research. Since the separation questionnaire is designed specifically for AWOs, the literature review focuses on investigations of military aviator retention.

The primary purpose of the literature review is to determine the factors that historically have been related to retention of military aviators. These factors helped define the types of information that the questionnaire must contain to yield the necessary data about AWO attrition. Two additional sources used to define information requirements are (a) interviews of AWO attritees and subject matter experts (SMEs), and (b) reviews of existing Air Force and Navy separation questionnaires.

Specific items representative of each of the major categories of information requirements were then designed. These items were compiled to form a preliminary version of a four-part separation questionnaire.

Part I of the preliminary questionnaire contains items designed to determine the demographic characteristics of AWOs who separate from the Army. Parts II and III consist of career factors that are rated by respondents on a 7-point numerical scale. In Part II, the respondents rate each career factor to indicate their opinion of the factor for determining job satisfaction. In Part III, the respondents rate the same career factors to indicate the influence that each factor had on their decision to remain in or to leave the Army. Part IV contains items designed to yield feedback about the suitability of the questionnaire's content and format.

Following construction of the preliminary questionnaire, a field test must be conducted. The field test data will be collected from respondents who are selected from two criterion groups--attritees and retainees. Attritees are defined as AWOs who have indicated their intentions to leave the Army, either at the end of their initial obligation or following a voluntary extension of their service. Retainees are

defined as AWOs who have extended their service beyond their initial obligation and who have indicated their intentions to remain in the Army. The questionnaire will be administered by the project director or by local points of contact (POCs) at installations where the respondents are located.

The field test data will be analyzed and the results will be used to produce the final version of the separation questionnaire. Particular emphasis will be given to inclusion of items that (a) are shown in statistical analyses to discriminate between AWO attritees and AWO retainees, and/or (b) are identified as having particular relevance for Army personnel and policy decisions.

Once the final questionnaire is developed, it will be submitted to MILPERCEN for Army-wide administration to all AWOs leaving the Army. Information provided by the questionnaire will be analyzed to produce quarterly reports of AWO losses to the Army and the factors influencing the AWOs' decisions to leave the Army.

PROJECT STATUS

Work Completed

The preliminary version of the separation questionnaire has been developed. Initial feedback about the preliminary questionnaire has been derived through the project director's personal administration of the questionnaire and through interviews with the respondents.

Further field test data collection from AWOs who leave the Army at the end of their initial obligation must be delayed until August 1983. This delay is necessary because of the year of ineligibility for attrition of first-term AWOs. The period of ineligibility, which extends from 1 August 1982 to 1 August 1983, is due to the transition from a 3-year to a 4-year initial commitment in FY 1979.

A summary report of ARI's AWO retention research has been written. The report presents an overview of past research, research currently in progress, and projections for future research.

Projected Date of Completion

Current projections are that the field test data collection and preliminary data analyses will be completed in FY 1984. Pending completion of these tasks, the final questionnaire will be available in late FY 1984.

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DEVELOPMENT OF A 1984-85 VERSION OF THE ARMY FLIGHT APTITUDE SELECTION TEST

Dr. Robert E. Lockwood, Project Director

BACKGROUND

This research project is a part of a continuing ARI program to ensure that the Army's procedures for selecting applicants for Initial Entry Rotary Wing (IERW) flight training remain effective and valid.

The Army's initial selection device--the Flight Aptitude Selection Test (FAST)--was developed during the 1950s in response to the problem of unacceptable attrition from the flight training program. The FAST was composed of two batteries--an Officer Battery (OB) and a Warrant Officer Candidate Battery (WOCB); each battery yielded a fixed-wing and a rotary-wing aptitude score for each applicant (Kaplan, 1965). The FAST was implemented in 1966 and resulted immediately in a reduction in attrition.

In 1974, a reassessment of the predictive validity of the FAST showed that it still was an effective and valid test for selecting applicants for flight training (Eastman & McMullen, 1978a). However, by this time the Army had ceased to train initial entry students in fixed-wing aircraft, so there was no longer a need for the fixed-wing aptitude scores from the FAST. For this and other reasons, a decision was made to revise the FAST. Another motive for revising the FAST was the desire for a single test battery that can be used for all applicants and that contains fewer, shorter, and more easily scored subtests. The revision was based on a factor analysis of both FAST batteries and a regression analysis of the FAST subtests. The resulting battery--the Revised Flight Aptitude Selection Test (RFAST)--contains seven subtests from the FAST; each subtest contains approximately one-half the items from the original subtest (Eastman & McMullen, 1978b). The FAST subtests and items used in the RFAST were selected because of their predictive validity. That is, the subtests that correlated most highly with successful performance in

IERW were selected as subtests for the RFAST. Then, the items on each subtest were reduced in number by selecting items that had the highest item validities until each subtest was approximately one-half its original length.

The RFAST became operational in 1980. The data that are needed to evaluate the effectiveness of the RFAST did not become available until early 1982. This delay was caused by the time that elapses between testing and the beginning of flight training, and the nine-month duration of the flight training program. Consequently, this research began, using the data now available, with an evaluation of the effectiveness of the RFAST as a predictor of performance in the IERW training program.

PROJECT OBJECTIVES

The ultimate objective of this project is to develop a more effective version of the Army's Revised Flight Aptitude Selection Test. The specific technical objectives of this research are as follows:

- Determine appropriate criterion measures of IERW proficiency.
- Determine the relationship between criterion measures and the components of IERW.
- Identify the criterion measures predicted by the RFAST.
- Identify requisite abilities necessary to successfully complete IERW.
- Identify the abilities now being assessed by the RFAST.
- Develop a future version of the Army's Flight Aptitude Selection Test with all ancillary materials.

RESEARCH APPROACH

The general research approach is an investigation of the current predictive validity of the RFAST, followed by traditional test development activities that will result in an updated version of the RFAST.

The objective of the first phase of the research is to conduct a detailed statistical analysis of the RFAST. The analytical computations include an item analysis of the 200 items in the RFAST, reliability

estimates for component subtests and for the total battery, and estimates of subtest validity and total battery validity. To compute the validity estimates, it was first necessary to identify meaningful criterion variables from IERW. As an aid in selecting these criterion variables, attrition data were reviewed to determine the training phases in which involuntary attrition occurs most frequently (Roth, 1980). This review revealed that most flight-deficiency attrition occurs in two training phases: primary training and instrument training. The criterion measures selected from these phases were:

- hours to solo,
- primary IP grade,
- primary evaluation grade,
- basic instruments IP grade,
- basic instruments evaluation grade,
- advanced instruments IP grade, and
- advanced instruments evaluation grade.

One additional criterion measure was selected for investigation that is not a part of the primary training phase or the instrument training phase. This criterion measure--Final Class Standing--is based on the weighted average of all academic and flight examinations that a student takes during IERW. These criterion measures were used in regression analyses to determine the validity of the RFAST when predicting performance in IERW.

An investigation of the current IERW training program was undertaken to identify the abilities required to successfully complete IERW. This investigation used subject matter experts (instructor pilots) to define the critical tasks that are indicative of successful performance in the primary and instrument phases and, then, to estimate what abilities are required to perform these critical tasks (Theologus, Romashko, & Fleishman, 1970).

An investigation was also undertaken to determine the abilities assessed by the current RFAST. Psychologists from the Army Research Institute Field Unit and Anacapa Sciences were the subject matter experts used to determine the abilities assessed by the RFAST.

After the identification of the abilities required to complete IERW and those being assessed by the RFAST is complete, a comparison between the two will indicate abilities that should be considered for potential test development activity. The inclusion of new subtests that measure the abilities thus identified may increase the validity of the RFAST.

The second phase of this research will consist of traditional test development activities. Based on the item analysis data, the current subtests from the RFAST will be modified to increase reliability and validity. Using the data from the abilities analysis, additional subtests will be investigated for possible inclusion in an updated version of the RFAST. Once the updated version is developed, a pretest will be conducted to ensure that the test is functioning as designed. Following the pretest, statistical analyses will be conducted to document the reliability and validity of the updated version. The final activity will be to compile two parallel versions of the updated RFAST and to develop all ancillary materials, including answer sheets, test administration manuals, directions, and scoring keys.

PROJECT STATUS

Work Completed

The statistical analysis of the RFAST has been completed, with the exception of a cross-validation of the regression equations generated for the four categories of criterion variables. The item analysis data indicate that the current RFAST is a heterogeneous battery composed of six homogeneous subtests and one heterogeneous subtest. The one heterogeneous subtest, Self-Description, appears to be unrelated to total battery scores. With the exception of the Self-Description subtest, all subtests have acceptable estimates of reliability, ranging from .64 to .88, with the total battery reliability estimated to be .90.

The validity of the RFAST as a predictor of success in IERW was investigated using regression analyses with each of the following criterion variables:

- hours to solo,
- primary IP grade,
- primary evaluation grade,
- basic instruments IP grade,
- basic instruments evaluation grade,
- advanced instruments IP grade,
- advanced instruments evaluation grade, and
- final class standing.

The results of these analyses indicate validity coefficients ranging from .23 (Hours to Solo) to .46 (Final Class Standing) for the entire sample of Officers and Warrant Officer Candidates. Separate analyses for each of these subsamples yielded validity coefficients ranging from .29 (Primary Evaluation Grade) to .56 (Final Class Standing) for Officers and from .27 (Hours to Solo) to .48 (Basic Instruments Evaluation Grade) for Warrant Officer Candidates. The addition of the General Technical and Skilled Technical subtests from the Armed Services Vocational Aptitude Battery for the Warrant Officer Candidates increased the multiple correlation with Final Class Standing to .54 and .68, respectively. Data from a second sample of IERW students are now being collected for a cross-validation of these regression equations.

The procedure for identifying the abilities required to complete IERW has been implemented. The results of this investigation will be compared with the abilities assessed by the RFAST to determine potential areas for test development. In addition, project personnel will conduct a review of the other services' selection procedures, as well as experimental batteries currently under development for ARI, to determine the degree to which the abilities identified in this research are being assessed.

Projected Completion Date

A research report that fully describes the statistical analysis of the RFAST will be completed by 15 November 1982. The report is an evaluation of the RFAST as a predictor of performance in IERW. A second research report on the investigation of the abilities required to complete IERW is in preparation and will be available by 1 January 1983. The second report will contain a detailed description of the

procedures used to identify critical abilities and recommendations for future test development activities.

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ATM REQUIREMENTS VALIDATION

Dr. John W. Ruffner, Project Director

BACKGROUND

With the introduction of the Aviation Career Incentive Act of 1974, Congress and the General Accounting Office established that the Army's flying-hour program funding would be acceptable only if it is fully justified. At that time, the Army was less able than the other services to demonstrate a definitive program that carried the aviator through qualification, mission, and continuation stages of training and specified tasks required in each training stage. The Army could produce only an annual flying-hour program requiring 80 hours for each aviator; no satisfactory explanation could be given as to how and to what benefit these hours were being used.

At the direction of the Vice Chief of Staff of the Army, a special task force from the Army Training and Doctrine Command (TRADOC) was created in late 1976 to develop a flying hour program structured around readiness. The product of this task force was the Aircrew Training Manual (ATM) program (Lovejoy & Presley, 1980).

The ATMs specify the training required to qualify individual Army aviators to operate specific aircraft/systems. The manuals provide lists of individual flying tasks that must be mastered and specify the standards for the satisfactory performance of these tasks. The manuals also specify, for aviators who are classified in a mission-ready status, the minimum number of times each ATM task must be performed (practice iterations) and the minimum total number of hours that must be flown during a six-month period of continuation training. Continuation training is the training that qualified aviators must receive to maintain their currency and proficiency.

Task iteration and flying hour requirements are specified for two Flight Activity Categories (FACs). The FACs are categories of aviation positions. Positions designated as FAC 1 require aviators to perform combat, combat support, or combat service support missions. FAC 1

aviators must be proficient in the tactical tasks appropriate for the type aircraft flown (e.g., utility) and for the mission of the unit to which the aviator is assigned (e.g., troop support). Positions not falling in FAC 1 are considered FAC 2 positions; these positions require the maintenance of basic flight skills. A task list for each FAC 1 and FAC 2 position is established by the commander, depending on his evaluation of the probable employment role of that position (TC 1-134, October 1980).

The ATMs serve several important functions for the aviation unit commander. They help him assess the combat-ready status of the unit, identify performance deficiencies of individual aviators, and develop and implement the required training program.

NEED

The U. S. Army Research Institute Field Unit at Fort Rucker (ARI) was requested by the Directorate of Evaluation and Standardization (DES) in 1980 to validate the ATMs. It was stated that the validation effort was to focus on the task iteration and flying hour requirements, which were defined initially by a group of subject matter experts (SMEs). Since the cost of flying hours continues to increase, a need exists to determine empirically the minimum number of ATM task iterations and the minimum number of flying hours that will maintain combat flying proficiency in Army aviators. These data are needed to ensure the effective utilization of valuable training resources, including: flying hours, aircraft, instructor pilot time, and aviator time.

PROJECT OBJECTIVES

The ATM Requirements Validation project has three specific research objectives:

- Determine the minimum ATM iterations and flying hours required to maintain minimum aviator proficiency in continuation training.
- Provide empirical performance data to support the Army's Flying Hour Program.

- Predict aviator performance, at the end of a six-month test period, on a selected set of FAC 2 tasks based on: amount of practice, length of no-practice period, previous experience, and initial skill level.

RESEARCH APPROACH

Because of time and resource constraints, the scope of the ATM Requirements Validation project has been initially limited to the investigation of task iteration requirements for a continuation training program designed to maintain proficiency in FAC 2 tasks. Once the task iteration requirements have been determined, it will be possible to estimate the flying hours necessary to meet these requirements as well as other unit mission requirements.

A two-phase study was designed to accomplish the objectives of this project. Phase I consists of a methodology to determine systematically task iteration requirements for a group of FAC 2 aviators in a controlled experimental environment, using a single low-cost rotary wing aircraft. Phase II consists of a methodology utilizing SME judgments to extrapolate Phase I data to other rotary wing aircraft.

Phase I, in progress at the end of the first contract year, consists of a field experiment being conducted at the U. S. Army Aviation Center at Fort Rucker. The test subjects for this experiment are 81 FAC 2 staff aviators who were stationed at Fort Rucker at the outset of the study and who will remain at Fort Rucker for the duration of the six-month test period. Staff aviators do not fly as a regular part of their duty assignments, but are required to meet ATM semiannual task iteration and flying hour requirements.

The test subjects are given initial checkrides to establish their baseline performance. Then, they are assigned to one of seven groups in such a way that the mean number of rotary wing flight hours completed by group members prior to the outset of the study is approximately the same for the seven groups. During the six months following that checkride, subject groups are scheduled to perform zero, two, four, or six iterations of a FAC 2 task list in the UH-1 aircraft.

The group flying zero iterations is the no-practice control group. Half the groups performing two, four, or six iterations are scheduled to fly during the first three months of the test period, while the other half are scheduled to fly during the second three months. Hence, the treatment of the seven groups differs in the number of practice iterations received during the six-month period and when, during the six-month period, the practice is received.

The UH-1 was selected for use in Phase I primarily because it is the aircraft used by the majority of FAC 2 aviators to maintain minimum proficiency.

At the end of the six-month period, the test subjects are given final checkrides to measure their proficiency. The final checkrides are scheduled to be completed in December 1982. Instructor pilots from the Aviation Center are responsible for conducting all checkrides, supervising all practice flights, and collecting performance data during the checkrides and practice flights.

Data from the final checkrides will be analyzed in order to determine the effects of several operationally relevant variables on retention of flight skills. Among the most important of these are: number of task iterations, length of no-practice interval, previous experience (as measured by rotary wing flying hours), and skill level at the beginning of the test period (initial checkride score). In addition, data on the aviator's confidence in his ability to perform each task are being collected, both before and after the initial and final checkrides. These data will be analyzed to determine the relationship between confidence level and checkride scores both at the beginning and at the end of the test period.

During Phase II, scheduled for January 1983, a group of SMEs experienced in the UH-1, AH-1, and OH-58 aircraft will estimate the task iteration requirements for the AH-1 and OH-58 aircraft. The SMEs will base their estimates for each task on the data obtained using the UH-1 in Phase I. This group of SMEs will be assembled from the Aviation Center and, if possible, from selected aviation units.

PROJECT STATUS

Work Completed

At the end of the first contract year, all initial proficiency checkrides had been completed. Half of the test subjects had completed their practice iterations. Preliminary data reduction has been completed and data analyses are in progress for the initial checkride and practice iteration data. No data can be reported at this time.

Projected Completion Date

It is estimated that draft results will be available on or about 1 February 1983. The final report, having undergone formal review by ARI, should be completed on or about 1 May 1983.

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REVISION/VALIDATION OF THE INDIVIDUAL READY RESERVE (IRR) AVIATOR TRAINING PROGRAM

Mr. Daniel T. Wick, Project Director

BACKGROUND

It has been estimated that between 1.3 and 1.8 Army rotary wing aviators per cockpit seat would be required to sustain operations in any major conflict (Department of the Army, 1979). Currently, there is only one active duty aviator per aircraft seat in the Army inventory. This shortfall of Army aviators would be made even greater by a migration of officers from flying positions to staff positions during a major mobilization.

In 1978, the Department of the Army created the Individual Ready Reserve (IRR) Aviator Training Program as a means for eliminating the aviator shortfall that otherwise would exist during a major mobilization. The IRR Aviator Training Program is designed to fill the cockpit seats with individuals who once served successfully as Army aviators but subsequently chose not to remain on active duty. The fundamental premise underlying the IRR Aviator Training Program is that it is less costly to retrain former aviators and to maintain their flying skills through periodic refresher training than it is to train and to maintain a larger force of active duty aviators. This program differs from the Army Reserve and National Guard in that the IRR Aviator Training Program requires participation only once a year, rather than the monthly participation required by the other reserve programs.

The Reserve Component Personnel and Administration Center (RCPAC) was given the responsibility for administering the IRR Aviator Training Program. As initially designed the program required that an IRR aviator be assigned to a specific field unit and that he report to his assigned unit for a 19-day training period once each year at the outset of the program. Each unit commander was made responsible for developing a program to train the IRR aviator assigned to his unit. This arrangement proved unsuitable because RCPAC had no means of

standardizing or evaluating the type and quality of training that the IRR aviator received at his assigned unit.

In 1979, the ARI Field Unit at Fort Rucker was requested by the Deputy Chief of Staff for Operations (DCSOPS), in conjunction with Forces Command (FORSCOM) and RCPAC to develop a standardized IRR Aviator Training Program. The specific tasks that ARI was requested to accomplish are as follow:

- to evaluate the amount of deterioration in the flying skills of IRR aviators,
- to determine the amount and nature of training needed to correct this deficiency, and
- to develop a program for accomplishing the required training in a cost-effective manner.

Army Research Institute personnel commenced work on the assigned project by conducting a mail survey of (a) IRR aviators who had attended one or more on-site training periods, and (b) active duty personnel who had been directly involved in training one or more IRR aviators. The survey resulted in two clear-cut and important findings. First, it was found that the flying skills of the typical IRR aviator had deteriorated substantially during the period he had been away from active duty. Although the survey provided no precise measure of the amount and type of skill deterioration, the results clearly indicated that a significant amount of refresher training would be necessary to increase IRR aviators' flying skills to an acceptable level. Second, the survey results showed that the type and amount of training received by IRR aviators varied greatly from one installation to another. Training at some installations consisted of little more than self-study of military publications. At other installations, the entire training program consisted simply of passive rides in the copilot seat of a helicopter during routine mission-training exercises. Overall, there were few instances in which the IRR aviators judged their training to be adequate.

The survey results and information from subject matter experts (SMEs) were used by ARI personnel to develop a preliminary version of

a program of instruction (POI) for the IRR Aviator Training Program (Allnutt & Everhart, 1980; Everhart & Allnutt, 1981). The POI consisted of two training phases. Phase I consisted of training in basic flight maneuvers and in academic study of a wide range of topics. Phase II consisted of refresher training on Phase I maneuvers and academic topics, additional flight training in special and tactical maneuvers, and academic training in terrain analysis and map interpretation. All flight maneuvers trained in Phase I and Phase II were selected by FORSCOM for IRR aviators.

The preliminary version of the POI was used to train a sample of 17 IRR aviators on Phase I maneuvers; the 19 days of training were conducted at Fort Rucker by experienced instructor pilots (IPs). One year after the Phase I training period, 6 of the original 17 aviators returned to Fort Rucker for 19 days of Phase II training. The preliminary version of the POI proved to be generally effective, but the results revealed a number of ways in which the POI could be improved. The POI was revised in accordance with these findings.

NEED

Copies of the second version of the POI were distributed to field units along with a questionnaire designed to provide feedback on the POI's effectiveness. Instructor pilots were requested to use the POI and complete the questionnaire. An analysis of the questionnaire results revealed that two problems clearly compromised the effectiveness of the POI.

- Due to the lack of preparation by IRR aviators prior to their arrival at the unit, an unacceptably large portion of the 19-day training period was spent on academic topics.
- An excessive amount of instructor pilot time was required to complete the academic training specified in the POI.

It was the need to eliminate these problems that led to the initiation of the present project.

PROJECT OBJECTIVES

The three objectives of this project are:

- to develop self-study materials that IRR aviators can use at home or at the unit training site to complete some or all of the academic preparation,
- to modify the academic portion of the POI to reduce the amount of IP time required to administer the training, and
- to evaluate the revised POI in a controlled environment.

RESEARCH APPROACH

The research plan for the project identified five general tasks that must be accomplished to fulfill the objectives of this project. These tasks are discussed below under separate headings. A description of both the task and the outcome is presented for the tasks that had been completed by the end of the contract year.

Definition of Academic Training Requirements

The purpose of this task is to define the topics that must be covered in the academic portion of the training program and to specify for each topic the specific knowledge that IRR aviators must possess in order to complete the course successfully. This task was accomplished by a team of SMEs composed of experienced instructor pilots (IPs) and experts in training technology.

The consensus of SME opinion was that the academic units for Phase I training should provide the student aviator the knowledge necessary to pass the pilot's oral examination as outlined in the Aircrew Training Manual for the UH-1 aircraft (TC 1-135). It was also agreed that academic units for Phase II training would be limited to map interpretation and terrain analysis. The order, content, and number of academic units in the original POI were revised to cover more thoroughly the germane academic topics. The revised POI consists of 12 academic units for Phase I and 5 academic units for Phase II.

Development of Academic Training Materials

The original POI required 80 hours of IP lectures to cover the academic topics. The primary objective of this task is to develop a training approach and requisite materials that eliminate the requirement for IP involvement in academic training. An approach considered highly desirable is to provide IRR aviators with the opportunity to complete some academic study at home, prior to their arrival at the unit training site. Another desirable approach is to provide the IRR aviators with self-study materials that they can study at the training site during proctored study periods. Since the amount of time IRR aviators will devote to home study is uncertain, a combination of the two training approaches is employed; that is, each IRR aviator will be provided an opportunity to engage in home study and an incentive for doing so. However, because the amount of home study cannot be controlled, the program must be designed such that all or any part of the academic training can be accomplished through self-study at the unit training site.

Another factor to be considered in developing academic training materials is that individual IRR aviators can be expected to differ greatly in their need for academic training. Individual differences in the need for academic training stem from differences in the amount of flight time logged by the aviators, differences in the time that has transpired since the aviators have flown regularly, and differences in the aviators' fundamental abilities. Hence, an important objective was to develop academic training materials that enable individual aviators to (a) study only the topics on which their knowledge is deficient, and (b) proceed through the training as swiftly as their capabilities permit.

Three types of materials were developed: a comprehensive set of reference materials, a detailed study guide, and a set of diagnostic examinations. The use of the materials is explained in the following description of the general training concept.

- Step One--The reference materials and study guide are sent to the IRR aviator's home about four weeks before he is scheduled to arrive at the training site. The IRR aviator is instructed

that home study is not mandatory but that time spent on home study will increase the amount of on-site time that can be spent on inflight instruction. Aviators who choose to engage in home study are instructed to complete the work specified in the study guide.

- Step Two--The IRR aviator is required to complete a diagnostic (paper-and-pencil) examination as soon as he arrives at the training site. The examination contains 12 subtests that cover 12 academic topics. A score of 90% or greater on any subtest excuses the IRR aviator from further study on the academic topic covered by the subtest.
- Step Three--An IRR aviator who fails to score at least 90% on any subtest is required to complete the self-study material specified for that topic in the study guide. Once the self-study has been completed, the IRR aviator is required to take a second examination on the topic. Any IRR aviator who fails to score at least 90% on the second examination is provided one-on-one tutoring by an IP until the IP judges that the IRR aviator has sufficient knowledge about the topic. This procedure is repeated until self-study of all 12 academic topics has been completed.

Development of Inflight Training Plan

The goal in developing an inflight training plan is to enable IRR aviators to relearn flying skills as rapidly as is commensurate with safety. The flying tasks/maneuvers to be taught were specified by FORSCOM. The Phase I tasks/maneuvers include most of the tasks/maneuvers that must be mastered to qualify for FAC 2 positions. The main exception is that no training is provided on instrument flight tasks. In Phase II, IRR aviators are provided refresher training on all Phase I tasks/maneuvers and are trained on a set of tactical and special tasks.

Conduct On-Site Evaluation of POI

The objective of this task is to evaluate the POI's effectiveness when used to train a representative sample of IRR aviators under realistic training conditions. The research plan developed for this project stipulates that: (a) A total of 48 IRR aviators are to be trained at the U. S. Army Aviation Center (USAAVNC), Fort Rucker, Alabama;

(b) Each month for six consecutive months, a group of eight IRR aviators are to receive training on 19 consecutive days; c) The last group of aviators are to complete training on 19 November 1982; and d) The 48 IRR aviators are to return to USAAVNC for refresher training and Phase II training in 1983. Critical questions addressed by the evaluation include the following:

- How much time will the average IRR aviator devote to home study?
- Are the study guide and reference material comprehensive in their coverage of academic topics?
- Are the study guide and reference material sufficiently clear and easy to use?
- How much time do aviators require to complete the self-study of each academic training unit?
- How many flying hours do IRR aviators require to relearn the requisite flying skills?

Revise the POI

The objective of the final task is to use the information from the evaluation to refine the POI. The revision of the Phase I POI is scheduled for completion in July of 1983. The revision of the Phase II POI is scheduled for completion in June of 1984.

PROJECT STATUS

Work Completed

Training Materials and Examinations. The development of all training materials and examinations had been completed by the end of the first contract year. Completed products include:

- An 850-page volume of reference material--entitled "IRR Aviator Reference Material"--contains 9 Department of the Army aviation publications and 1 Federal Aviation Administration publication. The publications were selected and edited to provide a comprehensive, yet concise, set of reference materials that cover all germane academic topics.

- A 62-page study guide--entitled "IRR Aviator Study Guide"--is designed to define, for each of the 12 academic topics, the knowledge that must be acquired and the reference material that must be studied to acquire the requisite knowledge. The study guide also contains completion-type questions and computational exercises drafted to focus the IRR aviator's attention on specific information items of particular importance.
- A comprehensive diagnostic examination consists of 221 multiple-choice items that are divided into the 12 subtests; one subtest was developed for each of the 12 units of the POI. The examination items were developed by a team of four IPs and four psychologists. To assist in developing examination items, team members obtained a list of questions commonly asked during the oral examination given by the Directorate of Evaluation and Standardization (DES) standardization instructor pilots (SIPs).
- Twelve pairs of parallel unit quizzes are designed to assess the IRR aviator's knowledge of the subject matter in each of the 12 units of the POI. Unit quizzes cover the same content as the 12 subtests of the diagnostic examination.

Aviator Training. Twenty-four of the 48 IRR aviators scheduled to participate in this study have been trained. Flight time for hands-on flight instruction averaged 18.75 hours per aviator. The IRR aviators trained thus far required approximately 20 hours of proctored self-study to complete their academic training.

Data Tabulation/Analysis. Item responses and scores on the diagnostic examination and on academic unit quizzes, daily flight performance scores by maneuver, initial and final checkride scores, and demographic data have been transcribed and keypunched for all aviators trained thus far. A tally of aviators' responses on feedback forms has been completed. Tallies of options selected by aviators on the diagnostic examination and academic unit quizzes have been made. A simple *t*-test has been calculated between pretest and posttest scores on the diagnostic examinations. Descriptive statistics have been calculated for some demographic items. Selected findings are reported below.

Preliminary Findings

The IRR aviators trained thus far vary widely in their characteristics and experiences. The age of the IRR aviators varies from 29 to 47 years; the mean age is 34 years. The flight time logged while on active duty averages 1,622 hours, but some aviators have logged as few as 510 flying hours and some have logged more than 5,000 flying hours. The time that has transpired since the aviators' last regular flying experience was found to vary from 2 years to 12 years, with a mean of six years.

All 24 IRR aviators trained thus far have successfully completed Phase I training during the 19-day training period. Twelve of the 24 aviators have successfully completed both Phase I and Phase II training. A comparison of pretest and posttest scores show a large increase in academic knowledge.

The findings show that approximately 90% of all IP time is spent on actual flight training. Most of the remaining 10% of an IP's time is devoted to administrative paper work.

The preliminary findings suggest that the program has significantly reduced the requirements made on IP time and, at the same time, greatly increased the amount of training accomplished during the 19-day training period. Using the previous POI, many aviators were unable to complete all of the Phase I training during the 19-day training period. In contrast, as was stated above, one-half of the IRR aviators trained with the new POI have been able to complete both Phase I and Phase II training during the 19-day training period. It appears from this evidence that the revised POI should result in substantial savings to the Army, both in the overall cost of maintaining the reserve aviator force and in the time required to retrain a reserve force during a major mobilization.

Projected Completion Date

An interim report covering this first training period will be produced. It is estimated that draft results will be available on or about 1 March 1983 and that this interim report covering these results, having undergone formal review by ARI, will be completed on or about 1 June 1983.

Commencing in June 1983, the 48 IRR aviators trained in 1982 at the ARI Field Unit, Fort Rucker, will return for refresher training. This training will be conducted using the revised refresher training. Training procedures and data collection will be similar to those of the first training period. The training material will again be revised as described above. Draft results should be available on or about 1 August 1984. A final report covering the results of this project, having undergone formal review by ARI, will be completed on or about 1 November 1984.

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PROGRAM OF INSTRUCTION (POI) FOR RETRAINING INDIVIDUAL READY RESERVE (IRR) AVIATORS IN COBRA AIRCRAFT (AH-1)

Mr. Steven L. Millard, Project Director

BACKGROUND

A recent study of Army aviator assets revealed that there are approximately 5,500 individuals who, having completed Army rotary wing qualification training and fulfilling their service obligation, were released from active duty and chose to not join a National Guard or active reserve unit.

In 1978, the Department of the Army in concert with the Reserve Component Personnel Administration Center (RCPAC) initiated the Individual Ready Reserve (IRR) aviator training program. The IRR program's goal is to enlist in the program civilians who previously were qualified Army rotary-wing aviators, provide these individuals with the training they need to regain and maintain their flying skills, and use them as assets in active-duty aviation units should a major mobilization be required. The Army Research Institute (ARI) was subsequently tasked to develop, evaluate, and field a Program of Instruction (POI) to be used to retrain IRR aviators. The initial POI, developed in 1979, was designed to retrain IRR aviators in the UH-1 aircraft. The initial draft of the POI for the UH-1 IRR aviator training program was tested during 1980-81. In 1981, the original POI was refined and the revised POI is presently undergoing an evaluation at the Army Aviation Center, Fort Rucker, Alabama.[3]

NEED

Although the evaluation of the IRR aviator POI for the UH-1 aircraft is not yet complete, sufficient data are in hand to justify the conclusion that IRR aviators can regain their flying skills in the UH-1

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[3]The project to refine and evaluate the POI for retraining IRR aviators in UH-1 aircraft is described elsewhere in this report (pp. 20-29).

aircraft with an acceptably small amount of training in the aircraft. Having established that fact, there is a need to expand the program to retrain IRR aviators in other types of rotary-wing aircraft.

PROJECT OBJECTIVE

The objective of this project is to develop an IRR aviator POI for the AH-1 (Cobra) aircraft. The POI will be designed to retrain IRR aviators who were qualified in the AH-1 aircraft while on active duty. Although it is assumed that ARI will be tasked by RCPAC to test this POI, an official request to proceed with the test has not yet been received.

PROJECT STATUS

Work Completed

A draft POI has been completed and forwarded to ARI for review and comments. A two-phase POI was proposed. Phase I is a comprehensive 12-day curriculum consisting of 54 hours of academic instruction and 10 hours of flight instruction. The objective of Phase I is to requalify the reservist in selected visual flight tasks while occupying the rear seat. Phase II consists of 47 hours of academic training and 16.5 hours of flight instruction administered over a 14-day period. The objective of Phase II is to requalify reservists in selected visual flight tasks while occupying the front seat. Following Phase I and Phase II training, the reservist will be current and qualified in the AH-1G aircraft in accordance with Army standards for flights under visual meteorological conditions (VMC).

Projected Completion Date

The draft POI review process should be complete in late November or early December 1982 and the final POI delivered in January 1983.

CH-47 FLIGHT SIMULATOR TRAINING DEVELOPMENT STUDY

Dr. Robert E. Lockwood, Project Director

BACKGROUND

Although many improvements have been made in the realm of U.S. Army helicopter flight training, the most important part of the student's instruction is still performed in an aircraft under the direct supervision of an instructor pilot. This method is extremely costly in terms of time required on the flightline by both student and instructor and in terms of flying hour costs in today's sophisticated aircraft.

The costs became very apparent during the late 1960s when the Army experienced a rapid expansion of its aviation capability. The huge increase in the cost of aviation training that accompanied this period of expansion clearly indicated the need for economical synthetic flight training systems that could reduce the requirement to use operational helicopters.

To fulfill this need, the Army approved a Qualitative Materiel Requirement for development of synthetic flight training systems in July 1967. Concept formulation was initiated by awarding feasibility study contracts in December 1967. The results of the feasibility studies were positive, so it was recommended that development be initiated. Technical characteristics were presented at the Technical Characteristics In-Process Review in September 1968 and approved in November 1968.

A contract was awarded in June 1973 for the construction of an operational CH-47 flight simulator (CH47FS) equipped with a camera-model-board visual system. A preliminary acceptance test was performed at the factory during September 1976 and the final acceptance test was conducted at Fort Rucker in January 1977. An operational test of the CH47FS was begun in January 1977 and completed in August 1977 (U.S. Army Aviation Test Board, 1978).

The results of the operational test indicated that the CH47FS was an effective training device in both institutional and unit-training environments, although improvements were needed: in the day and night visual displays, in the maneuver demonstration system, and in the yaw motion cues associated with emergency conditions.

A Cost and Training Effectiveness Analysis (CTEA) of the prototype CH47FS was conducted by the Directorate of Combat Developments (DCD), USAAVNC, during the period January 1977 to February 1980 (DCD, 1980). A review of the CTEA was conducted by the Analysis Branch, Directorate of Training Developments (DTD), USAAVNC, during August 1980 (DCD, 1980). Based upon the review findings, it was concluded that the CH47FS CTEA report did not provide adequate data to address the following issues:

- What is the cost and training effectiveness of the CH47FS given significant design changes in the production model CH47FS, including the addition of a side window, a larger computer, and an advanced system technology motion system?
- What is the mix of simulator time and aircraft flight time that will maximize training benefits and minimize training costs?
- How should the Aircrew Training Manuals (ATM) be refined to reflect this mix?
- What should be the basis-of-issue-plan (BOIP)[4] that will maximize training effectiveness and minimize training costs?

NEED/PROBLEM

With the introduction of the production model of the CH47FS, there is a need to reevaluate the cost and training effectiveness of the simulator. This reevaluation is needed because of the design changes that occurred after the CTEA (DCD, 1980) was conducted on the prototype simulator. In addition, the data available from the original CTEA were not sufficient to address the issue of usage of the CH47FS in a unit-training context--specifically, unit continuation-training.

[4]The BOIP is the plan that specifies the number of simulators to be purchased and the installations to which the simulators are to be sent.

Thus, the need exists to reevaluate the cost and training effectiveness of the production model CH47FS for use in conducting unit continuation-training. The present research, therefore, is designed to determine the actual cost and training effectiveness of the CH47FS and to optimize its use for unit continuation-training.

One of the critical issues associated with any study of the effectiveness of flight simulators in a continuation-training program is the measurement of training effectiveness. Classical transfer designs use varying levels of aircraft time and varying levels of simulator time to train aviators to proficiency in a particular task or maneuver. The transfer effectiveness ratio is defined in terms of aircraft time saved by using the simulator, assuming all subjects are trained to proficiency (Roscoe, 1980). Within a continuation-training program, the emphasis is on maintenance of skills rather than on initial skill acquisition. Thus, training data from an institutional setting, where the simulator is used for initial skill acquisition, cannot be generalized to a unit-training context. Because of the lack of generalizability of institutional training data, it is essential that a study be conducted that focuses directly on the unit- training situation.

Within a unit-training program, three possible training options exist:

- train all tasks/maneuvers in the aircraft,
- train some subset of tasks/maneuvers in the simulator and the remainder in the aircraft, or
- train all tasks/maneuvers in the simulator.

The third option may be possible in theory, but is not a practical option for unit continuation-training because of the necessary flying conducted in support of other Army units. The first two options, therefore, represent the only practical training alternatives. An implicit assumption underlying the development of advanced flight simulators is that simulator training can be substituted for some aircraft training and, thereby, reduce training costs while maintaining proficiency. Thus, the usefulness of the CH47FS in a unit-training

situation must be established by demonstrating that there is some mix of simulator and aircraft training that is more cost effective than aircraft training alone.

PROJECT OBJECTIVES

The general objectives of this project are to determine the cost and training effectiveness of the CH47FS (production model) for unit continuation-training, and to define the mix of simulator training and aircraft training that is most cost effective for maintaining the flying skills of unit aviators. The specific technical objectives of this project are:

- Determine the total cost of each training alternative, where the training alternatives are the aircraft alone or the aircraft and simulator in varying mixes.
- Establish the relative training effectiveness of each training alternative.
- Recommend an optimal cost and training effective alternative for CH-47 aviator unit continuation-training.
- Based upon cost and training effectiveness, develop a valid list of ATM tasks for (a) the CH-47C helicopter as the desired training medium, and (b) the CH47FS as the desired training medium.
- Determine the adequacy of the present CH47FS BOIP and revise it as necessary.

RESEARCH APPROACH

The research approach developed for this project was designed to (a) define the ATM tasks that require some amount of continuation-training, (b) derive an initial estimate of the mix of aircraft and simulator time that will maximize training effectiveness while minimizing cost, and (c) use sequential analyses to monitor unit-training procedures and refine the initial estimate of the optimal mix of aircraft and simulator time. The proposed research will be conducted in three phases. Each phase is described below.

Phase 1: Training Survey

A training survey will be undertaken to determine the amount of aircraft and simulator training currently being received by operational CH-47 pilots. The survey will examine both training time and the number of practice iterations for both training flights and mission-support flights. The data from the survey will be used to define the initial mixes of aircraft and simulator training that will be investigated in the transfer-of-training study.

Phase 2: Transfer-of-Training Study

The transfer-of-training study is designed to determine the ATM tasks that require training and to derive, for each ATM task requiring training, an initial estimate of the training that is most cost effective. During the transfer-of-training study, the amount of aircraft training and simulator training will be controlled for each participating aviator. As stated above, decisions about the specific mixes of aircraft and simulator training to be investigated will be based on the data obtained during the survey of operational units.

A basic assumption underlying the transfer-of-training study is that certain flight skills deteriorate in the absence of practice. Given this assumption, it is then necessary to specify the skills that deteriorate and to determine the most effective method of maintaining those flight skills in operational units. Consequently, the proposed experimental design for the transfer-of-training study requires that four groups of aviators engage in the flight activity specified below:

- One group will continue to fly their normal aircraft missions during the period of the study, but will be required to refrain from any practice in the CH47FS.
- A second group will be restricted from all flight activity for six months.
- A third group will receive all their training in the CH47FS.
- A fourth group will be required to practice ATM tasks in both the aircraft and the simulator in accordance with a rigidly controlled practice schedule.

The training alternative that will maximize training effectiveness while minimizing training costs will be determined by assessing changes in proficiency for all participating aviators at the end of the six-month study period. By investigating varying mixes of aircraft and simulator time, it will be possible to specify, for each task/maneuver, the mix that produces optimal training effectiveness. Once these mixes are established, cost data for the simulator and the aircraft can be used to estimate the total cost for each training alternative.

Phase 3: Sequential Analysis

The transfer-of-training study will provide the data needed to (a) identify the ATM tasks that can and should be trained using some mix of aircraft and simulator training, and (b) derive an initial estimate of the mix of aircraft and simulator training that is most cost effective for maintaining an acceptable level of proficiency on each ATM task. Further study may be required for two reasons. First, since the optimal training-mix curves will be based on a relatively small sample of aviators, the initial estimate of the optimal training mix derived from the transfer-study data may be imprecise and, therefore, may result in some amount of undertraining or overtraining of aviators. Second, because all the data in the transfer study are based on a six-month study period, additional research may be required to determine whether the optimal mix data are valid for longer periods. It is altogether possible that a training mix that maintains proficiency for periods as long as six months may result in proficiency deterioration if continued for periods of 12 months, 18 months, or longer. It is for these reasons that the sequential analysis is considered essential.

The objectives of the sequential analysis are to monitor the unit continuation-training program and to modify the mixes of aircraft and simulator time, should the initial training mixes fail to result in optimal training effectiveness. The data required to conduct the sequential analysis will be collected from operational pilots in six-month increments after the completion of the transfer study. These data include:

- number of iterations for each ATM task completed during mission flights,
- number of iterations for each ATM task completed during CH47FS training, and
- data on task performance from checkrides given at the end of the six-month period.

When the data indicate that the training mixes of aircraft and simulator time fail to result in optimal training effectiveness, the data gathered to that point in the study will be used to adjust (refit) the training mix curves, and data collection will continue for another six-month period (Wald, 1947).

In order to collect data consistent with the requirements specified in the transfer study, each CH-47 aviator will be requested to restrict aircraft flight time to mission-essential flying. Any additional training will be conducted in the CH47FS, except for those tasks that cannot be practiced in a simulator. The additional training will be specified by the initial function generated during the transfer study for each task. Performance data from the aviators' checkrides will be used to determine if the mix of aircraft and simulator training is optimal. The sequential analysis will continue until there is a statistically sound basis for concluding that the training mix for each task is optimal.

PROJECT STATUS

Work Completed

A draft Training Development Study (TDS) plan has been developed and submitted to ARI for review. Once ARI personnel have completed their review, the plan will be forwarded to DTD. The final decision concerning implementation of the TDS will be made by DTD personnel.

Projected Completion Date

It is anticipated that the final study plan will be available in November 1982. The decision whether Anacapa Sciences will conduct

the study will be made by DTD and ARI. In the event that Anacapa Sciences is to conduct the study, the project start date will be in early 1983.

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SCOUT HELICOPTER TEAM MISSION SIMULATOR: A NEEDS AND FEASIBILITY STUDY

Dr. Jack B. Keenan, Project Director

BACKGROUND

This project was initiated by the Directorate of Training Developments (DTD), U.S. Army Aviation Center (USAAVNC) for the purpose of defining the extent of need for a scout team[5] mission training device and to assess the feasibility of developing such a device.

The three major factors that prompted DTD to initiate this research are (a) the importance and complexity of the scout helicopter missions, (b) the criticality to mission success of team coordination, and (c) the difficulties associated with the conduct of realistic, team training (DTD Fund Cite, 1981). Each of these factors are described in the following paragraphs.

Scout helicopter crews are organic to three combat units: attack helicopter companies, air cavalry troops, and division artillery (DIVARTY) flight support sections. The basic mission of the attack helicopter company (AHC) is to destroy armored vehicles. Scout helicopters support this mission by establishing and maintaining communication with the ground commander and with the crews of the attack aircraft to ensure proper integration of fires within the larger scheme of battle. The attack team leader, operating from a scout helicopter, manages the aviation assets during the mission. The remaining scout helicopters acquire targets and other combat information for the attack helicopters and reconnoiter avenues of approach to the engagement area and the firing positions. During the actual engagement, the scout teams (a) locate and maintain contact with the enemy, (b) designate

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[5]The term "team" is used to refer to any interaction between the crew members of two or more aircraft, or between members of an aircrew and the crew of a ground-based unit. The term "crew" is used to refer to interaction between the crew members of the same aircraft.

targets for attack helicopters, and sometimes for close air support (CAS) aircraft, and field artillery batteries as well, and (c) provide local security for the attack helicopters by searching for enemy activity in the immediate vicinity.

The basic mission of the air cavalry troop is to perform reconnaissance and provide security for ground forces. The air cavalry scout helicopter's primary function is to provide combat information to the supported unit commander. A scout helicopter is normally deployed as a member of a team, with other scouts or with attack helicopters, depending upon the nature of the enemy situation. The attack helicopters of the air cavalry unit provide overwatch protection for the scout. With such protection, the scout helicopters of the air cavalry unit can make first contact with the threat, forcing the enemy to reveal their position and strength and to commit resources for battle before they are fully prepared. When augmented with both attack helicopters and artillery support, the scouts provide a credible anti-armor capability and are capable, when necessary, of defeating a sizable tank force.

Scout helicopters provide an aerial platform that greatly augments the mission of the division artillery (DIVARTY) flight support section. Each division has ten scout helicopters that provide the Field Artillery Aerial Observers (FAAO) of DIVARTY with the capability of rapid maneuver to critical areas on the battlefield for observation and adjustment of artillery fire.

The variety of scout aircraft, scout personnel, and scout missions in these three combat units largely determines the scope of this investigation. Consequently, the scope of the research encompasses the missions performed by a scout helicopter crew alone as well as missions performed by teams composed of: a scout helicopter crew (OH-58 or AHIP) and one or more attack helicopter crews (AH-1 or AH-64), a scout helicopter crew and division artillery (DIVARTY) personnel, a scout helicopter crew and either a forward air controller (FAC) or a close air support (CAS) aircraft crew. The extended teams of interest

are listed below along with the abbreviations that will be used hereafter to refer to them:

- OH-58/AH-1 - The crew of an OH-58 scout aircraft and the crew of one or more AH-1 attack aircraft.
- OH-58/AH-64 - The crew of an OH-58 scout aircraft and the crew of one or more AH-64 attack aircraft.
- OH-58/DIVARTY - The crew of an OH-58 scout aircraft and DIVARTY personnel.
- OH-58/CAS - The crew of an OH-58 scout aircraft and a FAC or the crew of one or more CAS aircraft.
- AHIP/AH-1 - The crew of an AHIP scout aircraft and the crew of one or more AH-1 attack aircraft.
- AHIP/AH-64 - The crew of an AHIP scout aircraft and the crew of one or more AH-64 attack aircraft.
- AHIP/DIVARTY - The crew of an AHIP scout aircraft and DIVARTY personnel.
- AHIP/CAS - The crew of an AHIP scout aircraft and a FAC or the crew of one or more CAS aircraft.

Analyses of the air cavalry, aerial observer (artillery), and attack helicopter missions reveal that these helicopter crews are not capable of performing the full range of their combat mission tasks independently. Scout helicopter crews serve as the eyes and ears for ground commanders, artillery units, and attack helicopter crews. In this capacity, the scout crew is required to process large amounts of information quickly and accurately and to interact smoothly and efficiently with other battlefield elements. Mission success, in most instances, is directly contingent upon such spatially and temporally coordinated action.

The modern battlefield on which these crews must be capable of fighting is characterized by highly sophisticated weapons systems and a numerically superior threat force. In response to this situation, the new AH-64 attack helicopter and the Army Helicopter Improvement Program (AHIP) scout helicopter were developed. The advanced

technologies incorporated into the mission equipment of these aircraft can be expected to increase rather than decrease the requirements for team interaction. For example, the AHIP scout helicopter has a laser range finder/designation system that will designate targets for the laser-guided HELLFIRE missile fired from the AH-64 and for laser-guided artillery munitions. The target designation capability of the AHIP scout helicopter imposes a new and critically important requirement for team coordination by the AHIP scout crew.

As the importance of team coordination increases, the difficulty of conducting realistic team training also increases. Realistic team training under the multiple task loadings of the battlefield is not easily achieved. Training resources required to support such an effort are extensive. The necessary resources include ammunition (missiles and "smart" artillery rounds), fuel, ranges large enough for the conduct of realistic navigation exercises, ranges that are safe for ordnance and laser firing, realistic threat vehicles and aircraft, as well as friendly combat and combat support elements. Another complicating factor is that the AHIP scout is a two-seat aircraft that cannot support Instructor Pilot (IP) training and evaluation of both crew members during the same flight. The requirement to assess the need for and feasibility of developing a scout team mission training device that will simulate battlefield conditions and team coordination exists, in large part, because of such constraints on live training exercises.

PROJECT OBJECTIVES

The specific technical objectives of this project, as stated in the DTD Fund Cite, (1981) are listed below.

a. Identify all scout-attack or scout-field artillery mission tasks and skills for which team training is required to achieve or maintain proficient performance.

b. Determine the advantages and feasibility of training team tasks identified under objective a using actual equipment as compared with a simulation device.

c. Determine the simulation device capabilities which are necessary to achieve proficiency in performance of individual and coordinated team mission tasks.

d. Determine the feasibility (costs and benefits) of adopting a device with the capabilities identified under objective c.

RESEARCH APPROACH

A two-phase approach has been developed to accomplish the project objectives. The Phase I tasks are aimed at compiling a comprehensive inventory of the team tasks that must be performed by each of the crews under investigation and, for each team task listed, determining the extent to which an team training device is needed to train the task effectively. The tasks to be performed during the second phase are aimed at defining the costs and benefits of one or more candidate systems and, thereby, assessing the feasibility of developing a cost-effective team training device.

The following tasks will be performed in compiling an inventory of team tasks for each of the eight teams defined above:

- Define the basic missions of each team.
- Subdivide each mission into mission segments.
- Identify the mission segments in which some team coordination is required and prepare a detailed description of each team function.
- Develop a detailed description of the tasks that must be performed by each team member in order to accomplish the function.

The resulting inventory of team tasks will be the subject of a training requirements analysis. The purpose of this analysis is to answer the following sequence of questions about each team task: Is the task presently being training effectively? If not, can the task be trained effectively with conventional ground-based training techniques If no, can the task be trained effectively in the aircraft? Tasks receiving a negative answer on all three questions are candidates for training in a team training device. The completion of this task necessitates the collection of detailed information on the training

currently conducted at both training institutions and in operational field units. The data gathered on the training of OH-58 and AH-1 aviators will be used as a base from which to extrapolate, when necessary, and predict training for the new AHIP scout and AH-64 aircraft.

The information gathered at this point in the project will be presented to a panel of experts in both training technology and in the operating characteristics, mission equipment, and battlefield tactics of the aircraft identified earlier. The panel's job is to identify the tasks that can and should be trained in a training device rather than in an aircraft or classroom.

Phase II will be initiated only if the results show that there are a significant number of important team tasks that can be trained effectively only in an team training device.

The first task in Phase II is to consider all the tasks that can be trained effectively in a device and to develop a comprehensive list of training objectives. The general equipment characteristics necessary to achieve those training objectives will then be specified.

One or more design concepts for a team training device will be developed and specific equipment characteristics for each design concept will be defined. Cost data for each design concept will be developed. The benefits in potential dollar savings to be realized by using a training device to replace operational equipment will be specified. Finally, recommendations concerning the development of a design concept will be made.

PROJECT STATUS

Work Completed

A draft of the research plan has been developed and submitted for review to ARI. The generic missions of each extended team have been identified and detailed function descriptions have been developed for each of the different mission segments. The compilation of training data and the conduct of the detailed task analysis have been initiated.

Projected Completion Date

As proposed, a decision briefing to a panel of subject matter experts is scheduled for June 1983. Given a decision to continue with Phase II of the project, the anticipated completion date of the final report is September 1984.

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PREREQUISITES AND SELECTION CRITERIA FOR AH-64 ADVANCED ATTACK HELICOPTER CREW MEMBERS

Mr. Theodore B. Aldrich, Project Director

BACKGROUND

Army aviators selected to fly the AH-64 attack helicopter will encounter a greater workload and a greater division of labor between the pilot and copilot/gunner (CPG) than they have encountered in any previous Army helicopter.

The copilot/gunner position features a target acquisition and detection system (TADS) composed of high technology components that include forward looking infrared (FLIR), a video day television viewing system, and direct view optics. A laser range finder and an airborne laser tracking and target cueing system will aid the CPG in reducing target acquisition time and in accomplishing the target acquisition functions under adverse flight conditions. The TADS interfaces with a fire control system that enables the CPG to fire the Army's new Helicopter Fire and Forget missile (HELLFIRE) in several different modes. The AH-64 aircraft is equipped with a doppler navigation system that interfaces with the TADS and fire control computer. The operation of the doppler navigation system requires the CPG to perform a host of new and complex tasks. Finally, redundant controls are provided in the front crew station to enable the CPG to fly the aircraft when the mission or situation warrants (Hughes Helicopters, 1979).

The most striking example of the new technology in the pilot's crew station is the Pilot's Night Vision System (PNVS). The PNVS provides the visual information the pilot needs to fly the aircraft during darkness and under other adverse visibility conditions. The Integrated Helmet and Display Sight System (IHADSS) presents information to the pilot on a one-inch diameter, helmet mounted cathode ray tube. This display, generated in part by the FLIR sensor mounted in the nose of the aircraft, provides flight instrument symbology superimposed on a thermal "real world" contact display. The flight instrument symbols

provide information about heading, altitude, airspeed, engine power management, attitude, and trim. The FLIR image on the IHADSS allows the pilot to stay "outside the cockpit" while flying under conditions of restricted or limited visibility. The AH-64 pilot has an exacting and demanding job flying NOE in poor visibility conditions because the PNVS field-of-view is limited to 40 degrees. In addition to controlling the aircraft, the pilot must perform air-navigation tasks, weapon control and firing, emergency procedures, and must remain cognizant of the functions being performed by the CPG and the other combatants within the battle area (Hughes Helicopters, 1979).

Two tentative decisions have been made about the selection and training of AH-64 crew members. First, it has been decided that, initially, AH-64 trainees will be selected from the population of Army aviators who have demonstrated a high level of proficiency in the AH-1 (Hipp, 1978). The assumption underlying this decision is that highly proficient AH-1 aviators are likely to possess the abilities required to perform effectively in the AH-64. Second, the Army's current plans are to train all AH-64 aviators to perform both the pilot and the CPG functions (Browne, 1981). This decision is based on (a) a desire for maximum operational flexibility, and (b) individuals who possess the abilities to perform effectively in one crew position will also be able to perform effectively in the other crew position.

NEED

The AH-64 subsystems are so different and so much more complex than the subsystems in other Army helicopters that there is a strong reason to suspect that effective performance in the AH-64 may require that AH-64 crew members possess abilities above and beyond those required to perform effectively in other Army helicopters. Hence, there is a need to determine whether AH-64 crew members must possess unique abilities and, if so, to develop tests that can be used to select individuals who possess the requisite abilities (Human Resource Need, undated).

There is also reason to question the assumptions that there is a high degree of commonality in the abilities required for effective performance in the two AH-64 crew positions. Because of the differences in the tasks performed in the two crew positions and because of the differences in the subsystems used to perform these tasks, it is altogether possible that effective performance in the two crew positions may require different sets of abilities that are rarely found in the same individual. As a consequence, there is a need to determine whether or not the abilities required to perform effectively in the pilot position differ in type or extent from the abilities required to perform effectively in the CPG position. If it is found that different abilities are required, a need will exist to develop tests for selecting individuals with the requisite sets of abilities.

PROJECT OBJECTIVES

As suggested by the title, the general objective of this project is to define prerequisites and selection criteria for AH-64 crew members. The specific technical objectives are as follows:

- Identify for each crew position the critical crew functions required to perform the attack helicopter mission.
- Determine the critical crew functions, if any, that are unique to the AH-64.
- Develop for each crew position the predictors of the abilities required to perform the critical functions.
- Validate these predictors against performance measures in the AH-64 crew training program.
- Cross-validate the predictors against performance measures in the AH-64 crew training program.

RESEARCH APPROACH

The approach to be followed in this project differs from the traditional approach to aviator selection test development. Instead of a detailed analysis of the aviator tasks, the project will take advantage of a number of task analyses that already have been performed for the AH-64 (Applied Sciences Associates, 1981; Singer Company, 1977;

Applied Psychological Services, 1982). The test development will not deal with the entire inventory of AH-64 crew functions under the assumption that a large proportion of the AH-64 crew functions are the same as crew functions in the AH-1 aircraft. It is further assumed that the same fundamental abilities underlie the functions that are common to both aircraft. If the assumptions are valid, there is no need to develop test instruments to assess common abilities. Since all candidates for AH-64 qualification training are successful AH-1 aviators, it is presumed that all candidates possess an acceptable level of the common abilities. Selection measures developed in this project will be based on crew functions and the underlying abilities that are unique to the AH-64 aircraft.

A job sample test development approach has been selected to complement a separate project presently under way to develop test instruments to select students for the attack (AH-1) training track. That test development effort is based on AH-1 crew functions, so the resulting test instruments will assess the abilities underlying AH-1 crew functions (Myers, Jennings, & Fleishman, 1982). If the Army decides at some future time to select AH-64 aviators from the general population of flying students, it will be possible to base the selection decision on a combination of tests: (a) the fundamental abilities tests developed to select trainees for the attack helicopter training track and (b) the job sample tests developed during this project to assess the job-specific abilities that AH-64 aviators must possess above and beyond the abilities required to pilot the AH-1 aircraft.

Job sample tests were deemed more appropriate for selecting AH-64 crew members from among operational aviators who already have demonstrated that they possess the requisite abilities for flying. Moreover, the high technology hardware associated with the unique AH-64 crew functions provide an identifiable source of job sample test content.

PROJECT STATUS

Work Completed

Project personnel have become thoroughly familiar with the AH-64 attack mission and have completed a comprehensive review of the research literature on aviator selection. Task lists and task analyses conducted during the design and production of the AH-64 system have been collected and used to compile a composite list of AH-64 crew functions. The list includes 252 crew functions categorized as follows:

	AH-64 Unique	Similar to AH-1	Total
Pilot	63	106	169
Copilot/Gunner	64	19	83
Total	127	125	259

Each function has been listed on a separate worksheet along with the following information:

- mission phase,
- mission segment,
- source of information about crew function,
- associated equipment and/or subsystem, and
- explanatory comments.

For many of the crew functions, the information source contained detailed task descriptions in the same text where the function was located. The more detailed tasks have been listed on the worksheets for future reference in developing job sample tests.

The composite list of AH-64 crew functions has been formatted into a survey instrument that will be completed by AH-64 subject matter experts (SMEs). The SMEs will rate each of the 252 crew functions on four dimensions: difficulty to learn, probability of deficient performance, frequency of performance, and likelihood that deficient performance will have serious consequences. A tentative strategy has been devised for combining the results of the four ratings into an overall criticality rating. The overall criticality ratings of the various

unique AH-64 crew functions will be used to prioritize job sample test development activities.

Projected Completion Date

AH-64 Aircrew Qualification Training will start at Fort Rucker on 1 January 1985. Identification of the critical crew functions and development of the predictor test battery will be completed before the first students arrive for training. The predictor test battery will be administered to all attendees. The estimated completion date for the development and cross-validation of the predictor equations is 31 December 1985. The actual date of completion may vary depending upon the number of tests included in the battery and the number of students who flow through the training.

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A METHODOLOGY FOR DEVELOPING A FLIGHT GRADING SYSTEM

Mr. Theodore B. Aldrich, Project Director

BACKGROUND

A group of instructor pilots (IPs) responsible for training in the Combat Skills course of the U.S. Army's Initial Entry Rotary Wing (IERW) training program recently expressed their dissatisfaction with the gradeslip presently being used and requested that the Army Research Institute provide support in developing and evaluating an improved gradeslip (Shipley, 1981). Preliminary investigation indicated that the gradeslip was only one part of a more general problem. As a result, project personnel recommended that the scope of the project be expanded to encompass all aspects of the Combat Skills grading system. The project description presented below reflects the intention to investigate the full range of problems associated with the Combat Skills grading system.

NEED/PROBLEM

Many of the traditional problems associated with flight grading systems are manifest in the U.S. Army's flying training program. Daily flying lessons and periodic check flights within the IERW training programs are graded using a four-increment scale (A, B, C, or U). The standards for the four increments are stated in descriptive terms and allow for a range of individual instructor pilot judgments. The regulation prescribing the grading procedures calls for criterion-referenced grading, and yet the same regulation (U.S. Army Aviation Center, 1970) directs IPs to adjust grading standards to correspond to the student's phase of training.

The gradeslip contains a list of maneuvers that are to be graded, but the rationale for including the maneuvers on the gradeslip is obscure. The tasks listed on the gradeslip do not correspond exactly with either the tasks contained in the training syllabus or the tasks listed in the Aircrew Training Manual. Apparently, this lack of

correspondence is the result of training managers' failure to modify the gradeslip in step with changes to the training syllabus. This failure raises questions about training managers' requirements for grade information. Management information requirements for grades need to be identified and specified during the design of the grading system.

There are a number of human factors design deficiencies in the gradeslip: grouping of items is not functional, and the large number of graded items are crowded onto a small form by reducing the type size below established legibility standards.

The Combat Skills IPs receive limited and ineffective training on performance evaluation and grading. New instructors develop their individualized set of evaluation criteria based upon informal discussions with more experienced instructor pilots and upon their own experience from flight school and operational flying assignments.

PROJECT OBJECTIVES

This project has two broad objectives. The first objective is to develop and implement an improved grading system for the Combat Skills course. The second objective is to test a methodology for developing improved flight grading systems. A key attribute of this methodology is that experienced IPs play an important and continuous role in all aspects of the design process.

A set of secondary objectives, aimed at eliminating specific deficiencies in the present grading system, will be addressed during the development of the improved grading system. Grading criteria and standards will be defined and stated precisely. A gradeslip that satisfies management information requirements and complies with human factors standards will be designed. The gradeslip will feature a grading scale that contributes to interrater reliability and allows the IP to accurately record the grades in accordance with the established standards. A training program that instructs IPs and check pilots on how to grade flight performance accurately and consistently will be developed.

RESEARCH APPROACH

The approach to be followed in this project is described below in three phases: design and pretest, test and evaluation, and implementation.

Design and Pretest

Design of the grading system will be accomplished through a series of consensual decision-making design meetings involving eight Combat Skills IPs and four IPs assigned to key training directorates at the Aviation Center. Design features will be decided by IPs during consensual decision-making design meetings. Design decisions will be made about such features as the scale, the items to be graded, the system for calculating an overall grade, the frequency of grading, and the format for the gradeslip. Project personnel will accomplish the following tasks prior to the first design meeting:

- Conduct an audit of the training management information system for the purpose of documenting the requirements for flight grades.
- Perform a content analysis of the combat skills maneuvers.
- Develop human factors specifications to be used as design constraints for the design of the gradeslip.
- Develop grading system design guidelines.

The results from these tasks will be provided to the IPs as guidelines and factors to be considered in their design decisions.

The IPs who design the grading system will pretest the system by participating in flight tests in an instrumented helicopter. Results of the flight tests will be reported at subsequent design meetings and used to refine the grading system design. The flight tests also will be used to refine procedures to be used in the test and evaluation phase.

A program to train IPs on the new grading procedures and materials will be developed as the prototype grading system design nears completion. Video tapes recorded during the flight tests will serve as visual aids in the program.

Test and Evaluation

The test and evaluation phase will feature operational use of the prototype grading system during simultaneous inflight grading of students by two IPs. Prior to the inflight grading, participating IPs will be introduced to the prototype grading system through the training program developed earlier. The inflight grading will be performed initially in the Methods of Instruction (MOI) course used to train rated aviators to be Combat Skills IPs and subsequently in the Combat Skills course of instruction with actual students. After each flight, the two IPs will be asked to resolve their differences in grading through discussion of the student's performance on the graded items. Video tape recordings of the inflight maneuvers will be provided to assist the IPs in resolving their differences.

Additional pairs of IPs will be asked to grade the recorded maneuvers based only on the information they can derive from viewing the video tapes. Differences in grades (resulting from the video grading) will be resolved through consensual decision-making.

A fundamental assumption underlying this project is that the discussions IPs engage in to resolve differences in assigned grades will reveal valuable information about performance criteria and standards. Consequently, project personnel will be present at all discussions that IPs engage in to resolve grading differences, and will record information bearing on (a) the set of flight parameters that IPs consider in evaluating performance on a given maneuver, and (b) the relationship between assigned grades and the amount by which a flight parameter deviates from its command or "nominal" value. In short, all information will be recorded that may prove useful in defining performance criteria and standards.

The data compiled during this phase of the project will be analyzed and the results used to define tentative performance criteria and standards for each combat skills maneuver to be graded. In addition, the data on initial assigned grades will be used to measure the level of interrater reliability that exists prior to the introduction of the new grading system.

A series of design review meetings will be held to review the composite findings to this point in the project and to make final decisions about all aspects of the grading system. This series of meetings will be attended by a group of IPs selected from among those who participated in either the inflight grading or the video tape grading. The products that are expected to result from the design review meetings include:

- a listing of the individuals/agencies who use information on flight grades and the purposes for which they use the information,
- a listing of the flight maneuvers that are to be graded by Combat Skills IPs,
- a definition of the performance criteria and standards for each maneuver to be graded,
- a description of all grading procedures and materials,
- a description of the flow of information on grades throughout the training management system, and
- a complete training program design for use in training Combat Skills IPs to use the recommended grading procedures and materials.

Implementation

The third phase of the project consists of implementing the new grading system throughout the Combat Skills course. The training program on grading and performance evaluation will be administered to all Combat Skills IPs. Thereafter, the training program will be taught regularly as a part of the MOI course so that new IPs will be instructed properly on the subject of grading and performance evaluation.

A final report that describes all of the project activities and results will be written. The report will contain conclusions about the applicability of the project's methodology to other flight grading programs.

PROJECT STATUS

Work Completed

Considerable planning has been completed for this project. An issues paper has been written that reviews the relevant performance measurement literature and discusses the problems encountered when developing a new grading system within an operational environment. An analysis of the deficiencies in the existing grading system has been completed and a set of design criteria for the new system has been developed. Included in the design criteria are the major human factors considerations that will constrain and guide the grading system design.

An outline plan for conducting the project has been prepared in the form of a task flow diagram. Resources required for the duration of the project have been spelled out in fine detail. Manpower and logistic resources have been estimated for each step of the project on a weekly timeline.

One of the primary resource requirements is an instrumented UH-1 helicopter and an instrumentation package to support the inflight tests. An available helicopter and an instrumentation package adaptable for the project have been located, and preliminary commitments of support have been obtained.

IP manpower is another key resource required for this project. A briefing on the research plan has been presented to a group of Combat Skills IPs; the plan received their tentative endorsement. A subsequent briefing was presented to the Lowe Training Division Commander who is responsible for the Combat Skills course. He stated that he could not commit the required IPs to the project because present IP resources constitute only 75% of the authorized manning level. He suggested that project personnel further investigate the utility of the instrumented helicopter and informally discuss the grading system problems with IPs on an as-available basis until IP strength is increased to 90% of the authorized level in the Spring of 1983.

Projected Completion Date

The project plan presents an 88-week schedule from start to completion. The first phase, Design and Pretest, will require 35 weeks for completion. The second phase, Test and Evaluation, requires an additional 35 weeks. The results from each of these phases will be described in interim reports. Under the assumption that commitments of the required support and approval to proceed will be obtained by 1 March 1983, the interim reports will be produced in December 1983 and September 1984, respectively. The final 18 weeks of the schedule will be required for the implementation phase. Thus, project completion and the production of a final report is scheduled for January 1985.

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FIELD VALIDATION OF THE LIGHT ATTENUATION FILTERS (LAF)

Dr. Kathleen A. O'Donnell, Project Director

BACKGROUND

Terrain flying is a defensive tactic employed by pilots in a high-threat situation. The aircraft is flown at or below treetop level so that terrain, vegetation, and man-made objects can be used as masking and camouflage. The enemy's ability to detect the aircraft visually, optically, or electronically is greatly reduced under these conditions. When terrain flying is employed at night, it is an even more effective tool for enhancing survivability because of the increase in masking contributed by darkness. Flying at night without the use of external lights and with minimal internal lighting is called Night Hawk (NH) flight. It is clear that flight at such low luminance levels places special demands on the pilot's visual, attention, and reaction capabilities. These unique aspects of Night Hawk flight, combined with the unique demands of terrain flight, create a need for improved methods of training and maintaining Night Hawk terrain flight skills.

Four factors complicate operational unit training in NH terrain flight, however. First, there are safety considerations; NH terrain flight is one of the most hazardous modes of flight. Second, there is a shortage of instructor pilots (IPs) capable of training aviators to perform emergency maneuvers at night. Third, the conduct of NH training requires an alteration of typical duty schedules. Finally, perhaps the most important factor is the existence of local, civil restrictions on night terrain flying. For example, flight after 10:00 PM local time is not permitted on the island of Oahu, where the 25th Infantry Division is located, nor is night flying permitted in the Federal Republic of Germany, where combat readiness is critical.

The best and perhaps the only solution to the full range of problems associated with training terrain flying during darkness is a capability for training night operations during daylight hours. A device developed for use in training night operations during daylight

(TNOD) has recently been tested by the Army (Farrell, 1975; Bleda & Farrell, 1979; Peters, Bleda, & Fineberg, 1979; Bauer & Bleda, 1979; Bleda, 1979; Ciley & Allnutt, 1979; Ruffner, Ciley, & Wick, 1981). This device, the Light Attenuation Filter (LAF), consists of a two-piece "sandwich" configuration of molded polycarbonate, neutral density filters mounted in modified Army Sun, Wind, and Dust Goggle frames. Light reaching the eye through the LAF is reduced by a factor of 1,000,000. Therefore, the daylight image perceived through the LAF closely resembles a night visual scene. A bright, sunny day will appear to the aviator as a fairly bright, three-quarter moon night; a dark, overcast day will appear as a dark, moonless night.

Initial field tests of the LAF were conducted with UH-1 rotary wing tasks at Fort Rucker, Alabama. The aviation tests included flight and navigation tasks at both terrain flight and higher altitudes. Pilot performance on flying tasks with the LAF was found to be approximately the same as performance previously observed at night. Of particular interest is the finding that pilots flying with the LAF showed a pronounced tendency to drift to one side or to the rear during initial attempts at landing the aircraft and holding a stationary hover; these are the same tendencies that pilots exhibit under night conditions. To assess further the training potential of LAFs, a comparison was made of the flight task performance of two groups of aviators that were matched on total flying hours. One group trained during night conditions and the other group trained during the day with the LAF. No significant difference between groups during pretest or posttest performance at night was observed, and both groups' pretest to posttest gains were significant. Thus, it appears that the techniques learned with the LAF transferred quickly and effectively to NH flight conditions.

The LAF was found to degrade performance more on navigation tasks than flying tasks. The degradation of performance on navigation tasks is mainly due to the fact that the aviator's visual access to maps and instruments is dependent upon the aircraft's orientation with respect to the sun. When flying away from the sun, the ambient

illumination in the cockpit is very high. Under these conditions, aviators reported that the instruments and larger features on the maps are quite visible with the LAF and that thorough preflight planning will make it possible to perform navigation tasks while wearing the LAF. When the aircraft is flying into the sun, however, the instruments in the shadow of the instrument panel cannot be seen with the LAF. Moreover, aviators reported that maps cannot be read when the aircraft is flying toward the sun.

The inability to perform navigation tasks under all conditions necessitated an alteration of the filters. An area 1.5 cm^2 was cut out of the nasal portion of one of the filters, which created a small area where more light was transmitted to the eye. Through this area, the pilot has visual access to the maps and instruments.

The purpose of this investigation, then, is to assess the utility of the new LAF and accompanying LAF Training Module as a means of meeting the needs of field aviation units for training and maintaining NH flying skills. Additionally, the results of this investigation will be used to develop a fully exportable, modularized course of instruction (COI) for implementing the TNOD technique in field aviation units.

NEED/PROBLEM

The issue of user acceptability is one that must be resolved before a decision is made about the desirability of exporting the system to field units. A field validation, as conceived of here, evaluates the degree to which the potential of a product or system is achieved in an operational setting. Further, the field validation must be conducted to determine if the system meets users' criteria of acceptable performance.

The flying hours apportioned to operational units are barely sufficient to accomplish the unit's training program and funds to support extra flight time for research purposes are limited. Thus, it was determined that the approach to this research must require a minimum number of flight hours beyond those already programmed for unit training.

In addition, it was determined that the research approach adopted should create as few disruptions to the normal unit training program as possible. It was judged that the type and extent of controls needed for a field experiment would produce a considerable departure from the manner in which a field unit would implement the LAF training technique. Information about the LAF obtained under such contrived conditions might have limited generality to the average field unit training program.

In summary, resource constraints and the need to conduct this research under conditions that naturally occur in operational units strongly suggested the adoption of a non-experimental, survey approach to the validation effort.

PROJECT OBJECTIVES

The specific objectives of this research are as follows:

- to obtain performance and user acceptability data on the use of the LAF for the training of NH flight skills,
- to identify appropriate methods and materials for implementing the LAF technique for training night operations in daylight (TNOD) in aviation field-unit settings,
- to assess the utility of the LAF technique as a means of meeting the needs of field aviation units for the training and maintenance of NH flight skills, and
- to develop a fully exportable and modularized COI for implementing the TNOD program in aviation field settings.

RESEARCH APPROACH

All operational field installations that are currently under local civil restrictions on night flight will be identified. From these installations, two company-sized units with approximately equal numbers of rotary-wing rated aviators will be selected as sites for the validation effort. A point of contact will be established at each unit at the earliest possible date. Each unit will then be requested to retain all non-current copies of gradeslips for later analysis.

Checkride scores, questionnaires, and structured interviews will be used to obtain the performance and user acceptability information required to validate the LAF training technique. Scores from regularly scheduled Night Hawk (NH) qualification, refresher, and continuation evaluation flights will provide information relevant to the training effectiveness of the LAF. The user acceptability of LAF training will be evaluated in two ways. First, unit utilization of the LAF provides one measure of user acceptability. The proportion of NH training flights during which the LAF was used will be derived from the grade-slip (DA Form 4507-R), currently used in the units as a training record. Second, all LAF-trained aviators will complete a pre-training questionnaire, a post-training questionnaire, and a structured interview--all designed to obtain user appraisal of the training effectiveness of the LAF and user recommendations concerning the integration of LAF training with other unit training.

Three visits to each field unit will be made by the Project Director during a six-month period. The purpose of the first visit is to distribute the LAF and accompanying training module and to administer the pre-training questionnaire to all rated aviators in the units. Unit SIPs, IPs, UTs, the unit commander, and the unit training officer will be briefed on the purpose and schedule of the validation effort, the care and use of the LAF, and special LAF training implications. All available current and non-current NH training and evaluation gradeslips will be examined and relevant information will be recorded. A brief (15 to 20 minute) in-flight LAF orientation will also be conducted. A point of contact in the unit will be established during the first visit.

The second visit will be scheduled approximately one month after the initial visit. The objective of this visit is to review the units' implementation of the LAF training technique and ensure that the appropriate records are being maintained. A review of the tasks trained with the LAF will be conducted. If necessary, unit personnel will be encouraged to expand the use of the LAF to additional tasks.

Informal interviews with unit pilots, IPs, and unit training officers will be conducted to obtain information concerning any factors judged to be limiting the use of the LAF training technique. Where possible, solutions to such problems will be recommended.

The third and final visit to the units will be scheduled approximately six months after the initial distribution of the LAF. The objective of this final visit is to obtain any and all information relevant to the performance and user acceptability of the LAF training technique. Each aviator will be required to complete the post-training questionnaire in a structured interview format. All unit SIPs, IPs, and UTs who have conducted LAF training will be interviewed. All LAF and NH training and evaluation gradeslips completed in the previous six months will be examined and the data required for this project will be recorded.

Data Analyses and Recommendations

The outcome of the data analyses will serve as the basis for inferences about the training effectiveness and user acceptability of the LAF training technique. The training effectiveness and user acceptability information will be used to develop recommendations concerning the field implementation of the LAF training technique.

Actual unit utilization of the technique is the best available measure of user acceptability. A high ratio of LAF training to actual Night Hawk training will be interpreted as an indication of high user acceptability. A generally stable increase in this ratio over the duration of the research will be interpreted as evidence for an increase in the acceptability of the technique. An increase in this ratio in the 12 weeks prior to an aviator's evaluation flight will be interpreted as further evidence of high user acceptability. Questionnaire and structured interview data will be used to identify specific factors that might have limited the acceptability of the LAF training technique.

Overall flight and specific maneuver grades given during evaluation flights before and during LAF training will be compared for

information relevant to training effectiveness. Marked differences between these data sets may be a function of LAF training, and unit SIPs, IPs, and UTs will be questioned regarding such a possibility.

Finally, the LAF Training Module, which accompanies the LAF, will be revised in accordance with the results and the recommendations obtained.

PROJECT STATUS

Work Completed

The project is still in the preliminary stages. A research plan is nearly completed and soon will be submitted for internal review. The project is expected to progress smoothly once the field units targeted for use of the LAF have been identified and have agreed to participate in the research.

Projected Completion Date

It is anticipated that all aspects of the project will be completed by mid-November 1983. Initiation of the plan is expected by December 1, 1982; data collection should be completed by June 1, 1983. This allows 5.5 months for data analysis and report writing, reviews, and revisions. This schedule assumes that no difficulty is encountered in obtaining the necessary unit support.

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TRAINING HELICOPTER INITIAL ENTRY STUDENTS IN SIMULATORS (THIESIS)

Dr. Robert E. Lockwood, Project Director

BACKGROUND

Students entering the Army's Initial Entry Rotary Wing (IERW) course learn their basic contact flying skills in the TH-55 aircraft--a small two-place helicopter the Army uses exclusively for training. After 50 hours of in-flight training in the TH-55, IERW students commence training in the UH-1 aircraft.[6] There is a clear and pressing need to consider alternatives to training basic flight skills in the TH-55 helicopter. The reasons for this need are explained below.

Cost/Availability of Training Aircraft

The TH-55 is the only helicopter in the Army's inventory that requires high octane aviation fuel. In the event of a major fuel shortage, high octane fuel could become costly enough or scarce enough to disrupt the Army's IERW training program.

Another important concern is the impending end of the useful life of the TH-55. At present, no new TH-55 aircraft are being acquired to replace those in the aging fleet.

A phase-out of the TH-55 would require the Army to select from among three training options: the acquisition of a new training aircraft to replace the TH-55, the conduct of primary flight training in an aircraft that is now in the Army inventory, or the conduct of primary flight training in a flight simulator. It seems unlikely that a decision will be made to purchase a new training helicopter because (a) the Department of Defense has resisted proposals to develop and produce aircraft that are to be used solely for training, and (b) the Army has a strong desire to channel all available resources into operational

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[6] After becoming qualified in the UH-1 aircraft, students may join an operational unit as a UH-1 aviator or enter qualification training in another aircraft type.

equipment (Roscoe, 1980). The replacement of training in the TH-55 with training in an operational helicopter is not a promising option because most operational Army helicopters are far more costly and consume considerably more fuel than the TH-55 (Grice & Morresette, 1982). Based upon initial cost and fuel consumption alone, it appears that the OH-58 is the only helicopter in the Army inventory that is even marginally suitable for use in conducting primary training.

There are no data available for use in evaluating the feasibility of replacing training in the TH-55 with training in a flight simulator; the research reported here has been designed to provide the data needed to assess this option.

Availability of Training Resources

Because of limited training resources at Fort Rucker, the Army is unable to accommodate a large and sudden surge in the training load. During the mobilization of Army aviation for the Vietnam War, IERW graduates exceeded 5,000 per year. During this period, primary training in the TH-55 was conducted at Fort Wolters, Texas; only the advanced phases of IERW were conducted at Fort Rucker. When the Army phased down pilot training, all IERW training was consolidated at Fort Rucker, and the number of IERW graduates was reduced to fewer than 1,000 per year. The current IERW training load--about 2,000 students per year--severely taxes the usable airspace and physical facilities at the Aviation Center. In the event of another major mobilization, the Aviation Center would be hard pressed to increase the number of graduates to that of the Vietnam era without exceeding the capacity of existing airspace, stagefields, and other physical facilities at Fort Rucker. The reactivation of Fort Wolters is a feasible option, but a very costly one. It is possible that a more cost-effective option is to increase the training capability of Fort Rucker by increasing the amount of training that is conducted in flight simulators.

PROJECT OBJECTIVES

The specific technical objective of this research is to assess the extent to which contact flight training in a simulator transfers to a UH-1H aircraft for initial entry flight students. A factor complicating the accomplishment of this objective is the absence of a UH1FS equipped with a visual system. The lack of a UH1FS with visual system necessitates the use of a simulator for a different aircraft--the AH1FS, the CH47FS, or the UH60FS. Therefore, a secondary objective of this project is to identify the existing simulator that is the best surrogate for a UH1FS with visual system.

RESEARCH APPROACH

Overview

An experimental group of student aviators will be given training on basic flight tasks in a flight simulator equipped with a visual system and possibly other existing training devices as well. A matched control group will receive conventional training in the TH-55 aircraft. Then, members of both the experimental group and the control group will receive transition training in the UH-1 aircraft. The amount of time required to complete transition training in the UH-1 and measures of proficiency on selected flight tasks will be used to measure relative training transfer for the two groups.

Selection of a Flight Simulator

Three simulators with visual systems are available for training students during this research: the AH1FS, the UH60FS, and the CH47FS. The CH47FS has been eliminated as a viable option because of airframe and powerplant differences between the CH-47 and the UH-1H, the lack of a side window in the CH47FS, and the schedule of usage anticipated for the CH47FS. The AH1FS and the UH60FS present viable options for training. Both simulators have comparable visual systems, fidelity, and instructional features. Differences arise when comparing the simulators with the target aircraft, the UH-1H. The AH-1 and the

UH-1 are manufactured by the same company, are single-engine, two-bladed, single-rotor, skid-type helicopters. The UH-60 is a twin-engine, four-bladed, single-rotor, wheeled-gear helicopter. The UH-60 has advanced instrumentation that does not compare to the older UH-1H, whereas the AH-1 has almost identical instrumentation to the UH-1H. Consequently, in an effort to provide for maximum transfer, the AH1FS has been recommended for this research. It should be noted, however, that the selection of a flight simulator may well be dictated by availability rather than technical considerations.

Subjects

All subjects who receive primary training in the simulator will be volunteers who have received both a written and oral explanation of the research. To avoid an impact on the appointment and date of rank of Warrant Officer Candidates, all subjects selected for this research will be commissioned officers. A total of 16 student pilots, eight experimental and eight control, will be required for this research.

Method

The eight control subjects will undergo primary training in the TH-55 aircraft, receiving instruction from ACE instructor pilots. The eight experimental subjects will receive primary training in the simulator from Army Research Institute (ARI) and Anacapa Sciences, Inc. (ASI) instructor pilots. Both groups of subjects will receive the classroom instruction currently conducted in the IERW training program. Of necessity, the experimental subjects will receive a small amount of additional instruction specific to the flight simulator. At the completion of primary training, the 16 subjects will receive UH-1 transition training conducted by ARI/ASI IPs in a proficiency progression mode. In proficiency progression training, each subject progresses through the UH-1 transition training as rapidly as capabilities allow. Once the ARI/ASI IP judges that a student has reached criterion on all tasks, the student will be given an evaluation flight (checkride) with a

Department of Evaluation and Standardization IP using standard procedures and criteria.

Data Analysis

The objective of the data analysis is to determine the extent to which experimental subjects differ from control subjects in (a) the level of proficiency achieved in the UH-1, and (b) the rate at which the skill is acquired. The dependent measures to be analyzed include: daily grades on individual flight tasks/maneuvers, number of iterations of individual flight tasks/maneuvers, hours of flight time to complete UH-1 transition training, and checkride grades. Performance on each training task/maneuver will be analyzed separately. For the experimental and control groups, the mean and standard deviation of repetitions in UH-1 transition training will be reported. The t-test will be used to calculate the significance of mean differences on (a) DES checkride overall score and (b) flight time to completion of UH-1 transition training.

PROJECT STATUS

Work Completed

A draft of the research plan has been developed and submitted to ARI for review. The investigation to determine which simulator is most appropriate for the research has been completed. The results of the investigation are being prepared for an ARI/ASI meeting at which time a decision will be made about the flight simulator to be used during this project.

Projected Completion Date

The ARI/ASI meeting to decide which flight simulator to be used during this project should be convened in early November. Following that meeting, a final version of the research plan will be prepared and submitted to ARI. It is anticipated that project staff will begin training initial entry students in flight simulators during the second quarter of 1983.

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